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Pocket Gopher Food Habits on Two Disturbed Forest Sites in Central Arizona

Gerald J. Gottfried and David R. Patton

Abstract

Stomach analysis of pocket gophers (*Thomomys bottae*) indicated that on one area succulent grasses were the main food item, supplying between 84% and 44% of the average composite diet. Bromegrasses (*Bromus* spp.) were highly preferred. Thistle (*Cirsium* spp.) was the main forb eaten. The second area supported a forb-grass-brush cover after the forest had been removed. Forbs comprised about 70% of the herbaceous cover, and supplied 51% of the diet; grasses and sedges (*Carex* spp.) averaged 25% of the diet. Fleabane (*Erigeron* spp.) and common sunflower (*Helianthus annuus*) were the main forbs in the diet. Woody material, including ponderosa pine (*Pinus ponderosa*), was not used heavily throughout the period, although use did increase slightly during the winter. Insects were between 8% and 19% of the average diet.

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MANAGEMENT IMPLICATIONS

It often is difficult to regenerate conifers once the natural or seeded herbaceous and brush cover is established. Herbaceous cover competes with conifer seedlings for moisture (Embry 1971) and light, and supports a rodent population which feeds on the young trees. Regeneration activities should be started as soon as possible after a wildfire or harvesting activity to reduce these problems.

Although grass seeding provides rapid revegetation, it also improves gopher habitat. Therefore, grass should be seeded only where erosion is a problem and where range and wildlife benefits are the prime consideration. It is difficult and expensive to reduce natural or seeded vegetation and the associated pocket gopher (*Thomomys bottae*) populations once they occupy a site; but vegetation control may reduce both problems.

Researchers in Colorado (Keith et al. 1959, Tietjen et al. 1967) have suggested that gophers can be controlled by eliminating the forb component of the vegetation on high elevation grasslands. Results from this study as well as those of Burton and Black (1978), indicate that grasses also must be eliminated in some areas. Gopher populations should decline naturally after their food is destroyed. Follow-up herbicide operations may be necessary to maintain poor gopher habitat, or direct control measures could be used on the remaining animals.

Reforestation should be delayed until gopher populations have been sufficiently reduced to insure seedling success (Burton and Black 1978). Gopher control before harvest and rapid regeneration are recommended on areas with potential problems (Crouch 1982). A knowledge of gopher food habits as well as of their habitat requirements can help foresters identify lands where reforestation could be a problem. It gives managers the option of controlling gophers by direct methods or by manipulating their food sources.

INTRODUCTION

Pocket gophers, especially of the genus *Thomomys*, hinder successful forest regeneration on disturbed sites throughout the western United States (Crouch 1982, Burton and Black 1978, Heidmann 1972). Gophers kill conifer seedlings by cutting the roots or tops, or by girdling the roots or boles of larger seedlings and small saplings.

Pocket gophers are not common in a dense forest environment but are usually confined to natural meadows where there is sufficient food. The increase in herbaceous vegetation after overstory removal provides gophers with an adequate food supply.

Food habit studies have been conducted on *Thomomys talpoides* in Colorado (Keith et al. 1959, Ward 1960, Ward and Keith 1962) and in Utah (Marston and Julander 1961), and on *T. mazama* in Oregon (Burton and Black 1978). The Colorado research indicated that gopher populations can be reduced by controlling the forb cover. Keith et al. (1959) found an 87% reduction in gopher numbers, on a mountain grassland, after a herbicide treatment which reduced the perennial forb cover by 83%. Tietjen et al. (1967) concluded that *T. talpoides* cannot survive where succulent forbs have been eliminated, and that grass will only provide a marginal diet. However, they indicated that succulent grasses or those with corms or rhizomes will supply a subsistance diet.

The valley pocket gopher occurs throughout Arizona and parts of California. It has received relatively little study, although the various subspecies can be found from the desert shrub into the high elevation mixed conifer forests. *Thomomys bottae* food habits have only been studied by Bandoli (1981) in a pinyon-juniper shortgrass prairie, northeast of Flagstaff, and to some extent by Goodwin and Hungerford (1979) who were studying rodent populations within a managed ponderosa pine (*Pinus ponderosa*) forest south of Flagstaff.

Objectives of this study were to determine gopher food habits on two non-stocked forest sites where repeated attempts to plant ponderosa pine seedlings have had limited success, partially because of gophers. The study included the identification of preferred forb and grass species, and the relative extent that pine was utilized.

STUDY AREA

The study was conducted on two sites on the South Fork of Workman Creek, within the Sierra Ancha Experimental Forest, about 30 miles north of Globe, Ariz. The two study sites are representative of the general physical environment on the watershed, although there are differences in recent forest history and some differences in vegetation.

Climate, Soils, and Topography

Workman Creek is characterized by cold moist winters, dry warm springs and hot moist summers (Pase and Johnson 1968). Annual precipitation averaged 34.2 ± 2.1 inches from 1956 to 1981; however, only an average of 28% (9.6 inches) falls between June and September. The watershed is inaccessible between December and April because of the heavy snow cover. Annual temperatures average 48° F, varying from 31° F in January to 65° F during July and August.

Soil parent materials in the watershed are Dripping Springs quartzite, intruded by diabase and basalt, and Troy sandstone. Surface soils are of loam and clay loam texture with granular or crumb structures. Subsoils vary from clay loams to clay. Surface soil depth ranges from 3 to 10 inches, with total depths of around 30 to 50 inches. Elevations on South Fork range from about 6,700 to 7,270 feet. Both study sites were in the upper third of the watershed. One site, an old burn, is on relatively level terrain, while the other consists of two level areas connected by a steep slope.

Vegetation

The watershed originally contained mixed conifer stands on the moister sites and pure ponderosa pine on the upper, drier areas. The mixed conifer vegetation belonged to the *Abies concolor-Pseudotsuga menziesii/ Quercus gambelii* habitat type (Moir and Ludwig 1979). Plant species in the type are white fir (*Abies concolor*), Douglas-fir (*Pseudotsuga menziesii*), ponderosa pine, and Gambel oak (Quercus gambelii) with a minor component of quaking aspen (*Populus tremuloides*) and New Mexico locust (*Robinia neomexicana*). Only a few shade-tolerant herbaceous species (e.g., Canadian violet (*Viola canadensis*)) grew under the forest canopy (Pase and Johnson 1968). The ponderosa pine sites usually contained an understory of oak and locust, and a sparse herbaceous layer. Roadside areas and natural openings, however, contained a diverse grass and forb cover. The basal area for the entire watershed was originally 201 square feet per acre.

South Fork watershed was harvested by the single-tree selection method between 1953 and 1955. Logging removed about 46% of the merchantable trees and reduced the total basal area by 24% (Rich and Gottfried 1976).

Area History

Grass Area

In July 1957, a wildfire destroyed 60 acres of predominantly ponderosa pine in the upper, southeastern part of the watershed. Although the site was relatively level, the entire burn was seeded with a mixture of 2 pounds of crested wheatgrass (*Agropyron cristatum*), 3 pounds of intermediate wheatgrass (*A. intermedium*), 2 pounds of orchardgrass (*Dactylis glomerata*) and 2 pounds of yellow sweetclover (*Melilotus officinalis*) per acre, as an erosion control measure. A good stand of grass was established by the end of the first summer (Rich 1962). Locust and oak sprouts soon dominated the site.

Site preparation for tree planting began in 1966. Most snags were felled, downed material was windrowed and burned, and chemical brush and grass control operations were started. Brush control was successful, grass control was not; both activities were stopped by 1974 (fig. 1). Grass and forb production determined by double sampling techniques has varied from 1,729 pounds per acre (37% grass) during a wet year to 700 pounds per acre (69% grass) in a dry year. Some of the most common plants were: wheatgrass, bracken fern (*Pteridium aquilinum*), bromegrasses (*Bromus* spp.), and goosefoot (*Chenopodium* spp.). The burn was planted with 2-year-old ponderosa pine seedlings during the springs of 1967, 1973, and 1974, but success was spotty. Summer drought appeared to be the primary cause of initial mortality, although losses to pocket gophers were apparent from the start of planting. Gopher-caused mortality of surviving trees became more critical after the seedlings had become established. Some gopher baiting and trapping were attempted, but because this work could not be sustained, it only produced temporary relief.

Locust Area

This 73-acre site is near the south boundary, in the upper middle section of South Fork. It is part of a 203-acre unit which supported an uneven-aged mixed conifer stand that averaged 128 square feet of basal area per acre in 1966. Seventy percent of the basal area consisted of white fir and Douglas-fir, including some large trees with diameters greater than 30 inches d.b.h. Ponderosa pine and deciduous trees made up the remaining basal area.

In 1966, the unit was cleared as part of an experimental study to determine the effects on water production of converting from a mixed conifer to a pure ponderosa pine stand. The stand was to be maintained at a density of 40 square feet of basal area per acre which was estimated to optimize overall timber and water production (Rich and Gottfried 1976). Logging slash was broadcast burned, and some areas of ponderosa pine infected with dwarf mistletoe were cleared. The area revegetated to native grasses and forbs and to New Mexico locust and oak. In 1972, slash was windrowed and brush pushed and sprayed, and the area was mechanically scarified in preparation for planting pine in 1973 and 1974.

Surveys of the planted pine indicated that while drought was the main cause of seedling mortality, gophers affected regeneration success. The site revegetated to the cover before preparation (fig. 2). The most common species in 1974 were: bracken fern, figwort (*Scrophularia parviflora*), goosefoot, thistle (*Cirsium* spp.), and wild lettuce (*Lactuca* spp.).

METHODS

Gopher Collection

Pocket gopher trapping was concentrated, but not limited, to three clusters of plots randomly distributed within each area. Each cluster contained three plots, each 0.52 acres. Gophers were collected in the grass area from June through October 1975, in April 1976, and from June through August 1976. Collections were not made during the winter because of snow conditions. A total of 36 gophers were trapped. Animals were grouped into four collection periods for ease of analysis and because of the small sample size. Analysis of variance, based on monthly averages of grasses and forbs used, indicated that the group members were from similar feeding populations. Collections in the locust area were made during the two summers.

Period	Grass area sample size	Locust area
Summer 1975	13	6
Fall 1975	12	–
Spring 1976	4	–
Summer 1976	7	4

Although total sample size is small when compared to other studies (Ward and Keith 1962), it is adequate to indicate food habits and their fluctuations during snow-free periods over 15 months.

Gopher stomach contents were prepared and analyzed according to a modification of the technique developed by Sparks and Malechek (1968). Ten slides were prepared from each stomach, and contents were identified for 20 microscope fields of view on each slide. Stomach contents were compared to a reference collection from South Fork of similarly prepared plant slides.

Average percent stomach volume and percent occurrence values were calculated for each period. Percent volume calculated from the microscope field counts is the proportion of a food species in the stomachs and percent occurrence is the proportion of stomachs in which a species is found. The proportion of different plant parts (e.g., roots, stems, flowers) being consumed was not determined. Analysis of variance ($P = 0.05$) was used to compare gopher use of different species and species groups among and within periods.

Figure 1.—Grass area, in early spring, was seeded to grass after a wildfire in 1957. Grass accounted for 70% of the herbaceous cover. Snags and slash were piled and burned in preparation for tree planting.

Figure 2.—The locust area contains a forb-grass-brush cover which developed after the destruction of the original forest. Common sunflower (foreground) was one of the main pocket gopher foods in 1976.

Vegetation Sampling

Two techniques were used to sample vegetation in the primary study plots. In July 1975, percent cover was estimated by species for each plot. During the following July, sampling was done using the plotless point-quarter method (Cottam and Curtis 1956). Twenty-five randomly located points were established in each plot, and data were analyzed according to standard procedures for this method. Plant nomenclature and taxonomy followed Pase and Johnson (1968).

Individual species composition was not compared between the two years because of the sampling differences. The larger plant groups (i.e., grasses and sedges (*Carex* spp.) and forbs) were compared by Student's "t" test using percent cover and relative dominance.

Food Preferences

Pocket gopher food preferences were analyzed for summer 1976 by comparing the number of microscope fields occupied by a plant species or species group to the absolute density of the species in the vegetation sample. Preference analyses for the larger plant groups only considered species which were found in the diet. Statistical significance between species consumption and availability was determined using the technique described by Neu et al. (1974). The preference analysis for summer 1975 was limited to the larger plant groups because of the lack of specific plant density data. This

was justified because most of the key species are perennial, and their numbers would not fluctuate greatly from one year to the next.

Gopher Populations

Gopher populations were estimated by a procedure which was specific to the current effort. A value for average length of active shallow tunnel per gopher was estimated by excavating four systems and two systems on the grass area and locust area, respectively. The total length of active tunnel was determined on six, randomly located, 100-ft² subplots within each of the 18 plots. The total number of gophers per plot was calculated by dividing the length per plot by the average length per gopher value. These were converted to a per acre basis. Approximate variances of the estimates were calculated similar to Mood et al. (1974), and possible differences in population density between the two areas were assessed using the ratio of the population density difference to its estimated standard error.

Ponderosa Pine Survival

Thirty, bare-rooted, 2-year-old ponderosa pine seedlings were planted in each plot to determine mortality. Trees were planted in July 1975, during the summer rain period, and were evaluated periodically until September 1976. Mortality was attributed to drought and physiological problems (i.e., shock), to confirmed gopher activity, to unknown causes, and to winter-related problems. Missing trees were indicated as a separate category.

RESULTS

Food Habits

Grass Area

Wheatgrasses, bromegrasses, and Kentucky bluegrass (*Poa pratensis*), and grass-like species (sedges) produced 70% of the herbaceous cover on the plots during the two summers. The remaining 30% consisted of 12 forb species, mostly perennials. Four species that were identified in the gopher stomachs (i.e., pigweed (*Amaranthus* spp.), caterpillar-weed (*Phacelia magellanica*), deers-ears swertia (*Swertia radiata*), and the shrub Arizona honeysuckle (*Lonicera arizonica*)) were not found in the vegetation samples. The proportions of grasses and forbs in the total cover were more variable because of presence of New Mexico locust and Gambel oak sprouts which produced rapid growth over the year. Woody plants (e.g., New Mexico locust, ceanothus (*Ceanothus fendleri*), and Gambel oak) were 6% of the total plant cover in 1975.

Grasses were the main food for pocket gophers in this area for the first three of the four collection periods, but there was a steady decrease in their importance (table 1). Grasses were found in all of the stomachs collected from the grass area. Consumption by individual gophers varied from 99.8% to 57.3%. Use of bromegrass, primarily mountain brome (*Bromus marginatus*), was particularly high, while wheatgrasses, the most common species, were only a minor component of the diet.

Insects were a relatively large, consistent item in the diets (table 1) averaging over 10%. This is greater than the trace reported by either Ward and Keith (1962) or the 3% of Goodwin and Hungerford (1979). No attempt was made to identify insect species.

Forbs and shrubs-trees were of minor importance during the summer of 1975. The difference between forb and grass consumption was statistically significant during this period. Five forbs and one tree which were present in 1975 were not consumed.

The relative volume of grasses dropped slightly to 72% of the composite diet in the fall of 1975 (table 1). The difference between grass and forb consumption was statistically significant.

Total grass consumption in spring 1976 (table 1) declined by 16%, with a 22% drop in bromegrass. The changes, compared to summer 1975, were significant but not when compared to the previous fall. Differences between adjacent periods were not significant. Forb consumption, especially of thistle and geranium (*Geranium eremophilum*), rose in the spring from 16% to 25% of the diet (table 1), although this was not statistically different than for the previous periods. Heavy use of geranium in the spring has also been reported from Colorado (Tietjen et al. 1967). Use of grasses and forbs was not statistically different during the spring period. Although woody material was found in half of the stomachs, use of these plants continued to be minor. Burton and Black (1978) found relatively heavy gopher use of woody plants during winter in Oregon.

During the summer of 1976, grass consumption decreased to 44% of the composite diet (table 1). This was significantly less than for the previous summer or fall. Grasses continued to account for 70% of the herbaceous cover but total grass consumption was significantly less than expected (table 2). Forb consumption (48% of the diet) was significantly higher than for the first two periods (table 1) and was significantly greater than expected (table 2). Differences between grass and forb consumption during this period were not statistically significant. Three species were eaten but did not appear in the 1976 vegetation survey (i.e., mullein (*Verbascum thapsus*), caterpillar-weed, and ponderosa pine). Four species, which were present in summer 1976, were not eaten, although they were part of the diet during other periods. These were fleabane (*Erigeron* spp.) and red-and-yellow pea (*Lotus wrightii*), pigweed, and locust (table 1).

A total of 24 food items (table 1) were identified in the 36 stomachs collected from the grass area; grasses and sedges accounted for 5 items (21%), forbs for 13 items (54%), woody plants for 4 items (17%), insects and an unknown fungus accounted for the remaining 2 items (4% each). The average number of food items identified in the stomach samples varied from a high of 7.1 during summer 1976 to a low of 4.5 during the spring, reflecting the lack of food diversity at that time. Average diversity

Table 1.—Relative volume (percent) and frequency of occurrence (percent) of plant and and animal species in pocket gopher stomachs

Species	Grass area								Locust Area			
	Summer 1975		Fall 1975		Spring 1976		Summer 1976		Summer 1975		Summer 1976	
	Vol.	Occur.	Vol.	Occur.	Vol.	Occur.	Vol.	Occur.	Vol.	Occur.	Vol.	Occur.
Number of animals	13		12		4		7		6		4	
	Grass											
Bromus spp.	66.3	100	61.7	100	39.8	75	38.5	100	8.4	100	17.4	75
Agropyron spp.	6.8	62	1.2	67	1.7	25	1.5	86	8.4	67	0.4	25
Poa pratensis	1.4	100	8.5	100	15.1	25	3.8	100	1.0	33	1.6	50
Dactylis glomerata			0.9	8								
Total grass	84.5	100	72.3	100	56.6	100	43.8	100	17.8	100	19.4	75
	Grass-like											
Carex spp.			0.5	25					13.4	33	0.1	25
	Forbs											
Cirsium spp.			11.0	58	11.6	50	42.9	71			0.2	25
Geranium eremophilum			0.2	25	12.3	50	T	29	0.4	50		
Phacelia magellanica	2.6	85	0.2	42	1.1	25	1.1	86	0.2	67		
Lotus wrightii	0.1	15	T	17					T	17		
Swertia radiata	T	8	0.5	8					0.3	33		
Amaranthus spp.	T	15										
Verbascum thapsus	0.1	8	T	8			T	14	7.8	67	0.1	25
Erigeron spp.	T	8	3.8	50					31.4	83		
Lactuca spp.			0.4	25			0.9	57	1.8	17	11.3	100
Arenaria confusa					0.4	25					0.8	25
Pteridium aquilinum							2.1	43	0.5	33	3.6	100
Lathyrus graminifolius							1.3	14				
Helianthus annuus									6.3	50	36.2	00
Chenopodium spp.											0.7	50
Total forbs	2.8	92	16.1	83	25.4	100	48.3	100	48.7	100	52.8	100
	Shrubs-Trees											
Pinus ponderosa					0.1	25	0.1	29			1.6	75
Robinia neomexicana	T	8	T	8	0.1	25					0.3	25
Ceanothus fendleri	0.9	8	0.7	25	3.3	25					0.2	50
Rubus strigosus	0.2	23							1.2	17		
Sambucus neomexiana									T	17		
Rosa fendleri									T	17		
Lonicera arizonica	0.1	15										
Total shrubs-trees	1.2	39	0.7	33	3.5	50	0.1	14	1.3	50	2.1	100
	Miscellaneous											
Insects	11.5	62	7.5	92	14.5	100	7.8	86	18.8	67	15.2	100
Unknown (fungus)			2.9	17							10.4	75
Total	100.0		100.0		100.0		100.0		100.0		100.0	

T = Trace (<0.1).

during summer 1975 (5.2 species) was significantly less than during fall (6.8 species) or for summer 1976, but similar to the spring reading. Fall use was significantly different from spring use. One pocket gopher collected during the fall had eaten 10 different food items: 2 grasses, insects, sedges, 5 forbs, and ceanothus.

Locust Area

The herbaceous cover in this area consisted of 73% forb species. Sixteen species were sampled in 1975. The relative densities of wheatgrasses and bromegrasses were similar, although bromegrass was more widely distributed. Trees, shrubs, and half shrubs made up 37% of the total cover. Grasses and sedges were 18%, and forbs were 45% of the total cover.

Gopher feeding habits in the locust area were studied during the two summer periods. In 1975, forb species made up 49% of the diet (table 1). Fleabane, mullein, and common sunflower (*Helianthus annuus*) were the main species. All of the eaten forbs were represented in the vegetation sample. Grasses and sedges comprised about 31% of the diet; bromegrass and wheatgrass were eaten in equal proportions. All of the gophers had some grass in their diets. Grasses and sedges, which contributed 18% of the plant cover, were consumed in higher proportion than their availability, based on Neu

Table 2.—Gopher food preferences for the summer 1976: plant species consumption in relation to their availability for species counted in the vegetation survey and in stomach samples

	Microscope field counts					
	Grass area			Locust area		
	Observed	Expected	Sig.	Observed	Expected	Sig.
Larger plant groups						
Grass and grass-like species	645	1,123	*	146	114	
Forbs	589	111	*	425	452	
Shrubs				25	29	
Species						
Grass species						
Bromus spp.	524	246	*	127	54	*
Agropyron spp.	34	835	*	4	39	
Poa pratensis	87	42		15	9	
Grass-like species						
Carex spp.				1	21	
Forbs						
Cirsium spp.	494	2	*			
Geranium eremophilum	2	1				
Verbascum thapsus				1	12	
Lactuca spp.	26	7		110	195	*
Arenaria confusa				8	1	
Pteridium aquilinum	45	67		38	31	
Lathyrus graminifolius	22	33				
Helianthus annuus				259	149	*
Chenopodium spp.				7	101	
Shrubs-trees						
Robinia neomexicana				3	32	

* = *Significant at the 5% level.*

et al. (1974). Grass and forb consumption was statistically similar for both periods. Food habits in the locust area, however, were opposite to those of the pocket gophers in the grass area for the summer of 1975. Significantly more forbs and less grasses were eaten in the locust area. Wheatgrass utilization was similar for the two areas, but more bromegrass was consumed in the grass area.

The proportion of grasses and forbs on the area fluctuated slightly between the summers of 1975 and 1976. Twenty-eight forb species were sampled; of these, lettuce, common sunflower, and goosefoot were the most common (table 3). Shrub cover increased to 47%. The proportions of grasses and forbs eaten by gophers in the locust area did not change between the two summers. Both plant groups were eaten in proportion to their availability (table 2). Stomach analysis indicated that forbs were about 53% (table 1) of the diet in summer 1976, with sunflower and lettuce the main items eaten. Utilization of grasses and forbs was similar between the grass area and locust area during summer 1976. Insects were a relatively large component of the diet during both summers (table 1).

A total of 24 food items (table 1) were found in the gophers trapped in the locust area. This was the same number as in the grass area but there were some slight differences among the plant groups, primarily the larger variety of woody plants being used. Gophers collected during summer 1975 ate an average of 7.7 species. This indicated a more diverse diet here than for grass area gophers during summer 1975 or spring 1976. The average gopher ate 9.2 food items in 1976; a significantly greater diet diversity than existed during any of the four periods on the grass area. The large number of species used is directly related to the rich and diverse plant cover available in the locust area (table 3, fig. 3).

Gopher Populations

Measurements of active tunnel density indicated that the grass area supported a pocket gopher population (with standard deviation) of about 24 ± 7 animals per acre, and that the locust area supported a population of 16 ± 5 animals per acre. The average difference between the two areas (eight animals) was not statistically significant.

Ponderosa Pine Survival

Ponderosa pine seedling survival was poor on both areas. Only 3% of the seedlings survived until the end of September 1976 on the grass area, while 13% survived in the locust area. The difference was significant, but regeneration of both areas would be unacceptable by management criteria. Drought and related problems were the main causes of mortality on the two areas, ac-

Table 3.—Vegetation survey (percent) of study sites using plotless point-quarter technique, summer 1976

Species	Grass area				Locust area			
	Relative			Importance value	Relative			Importance value
	Density	Dominance	Frequency		Density	Dominance	Frequency	
Grasses and sedges								
Bromus spp.	19.1	11.4	20.0	50.5	5.5	1.6	6.0	13.0
Agropyron spp.	65.0	33.3	53.7	152.0	4.0	1.5	2.7	8.2
Poa pratensis	3.2	2.5	2.7	8.3	0.9	0.1	0.5	1.5
Carex spp.	0.3	0.5	0.9	1.7	2.1	11.4	2.3	15.9
Forbs								
Polygonum convolvulus	0.2	T	0.5	0.8	6.5	0.3	6.6	13.5
Lactuca spp.	0.6	0.5	1.2	2.3	19.7	2.8	17.1	39.5
Geranium eremophilum	0.1	0.1	0.3	0.5	3.5	9.4	4.0	16.8
Vicia americana					1.9	0.8	2.2	4.8
Phacelia magellanica					2.3	0.3	2.9	5.5
Helianthus annuus					15.0	5.1	13.3	33.4
Ipomoea spp.					0.5	0.1	0.5	1.1
Scrophularia parviflora					3.7	3.1	4.8	11.6
Chenopodium spp.	0.8	0.6	0.9	2.2	10.2	0.3	10.8	21.4
Pteridium aquilinum	5.3	15.7	8.8	29.7	3.1	11.5	3.8	18.4
Moldavica parviflora					0.9	0.1	1.3	2.3
Solidago missouriensis					0.2	0.1	0.2	0.4
Melilotus albus					0.2	2.5	0.4	3.1
Arenaria confusa					0.1	0.2	0.2	0.5
Melilotus officinalis	0.1	0.5	0.3	0.9	0.2	T	0.4	0.6
Verbascum thapsus					1.2	0.5	1.4	3.1
Erigeron spp.	0.1	0.1	0.3	0.5	1.0	T	0.9	1.9
Lotus wrightii	0.1	T	0.3	0.4	1.0	0.9	0.7	2.6
Oenothera hookeri					0.1	T	0.2	0.3
Lathyrus graminifolius	2.6	1.4	5.6	9.5	0.1	0.1	0.2	0.3
Monarda menthaefolia					0.1	T	0.2	0.3
Senecio spp.					0.2	T	0.4	0.6
Thalictrum fendleri					0.1	0.1	0.2	0.4
Houstonia wrightii					0.1	T	0.2	0.3
Amaranthus spp.	0.2	T	0.3	0.8	1.0	0.1	0.9	2.0
Galium aparine					0.3	0.2	0.2	0.7
Pseudocymopterus montanus	0.1	0.1	0.3	0.4				
Cirsium spp.	1.7	1.8	2.4	5.8				
Fungus					0.1	T	0.2	0.3
Woody plants								
Rubus strigosus					9.3	9.6	8.6	27.5
Robinia neomexicana	0.3	27.2	0.9	28.4	3.2	32.0	4.3	39.6
Symphoricarpos rotundifolius					1.7	5.3	1.4	8.4
Quercus gambelii	0.2	4.3	0.6	5.1				

T = Trace (<.1).

counting for 84% in the grass area and 62% in the locust area. Most drought mortality occurred during the first month on the grass area, and between August and October in the locust area. Mortality caused by gophers was equal (9%) for the two areas during the study period. However, 84% of these trees were killed in the first month on the grass area, compared to 12% for the locust area. The difference was significant. Sixty percent of the gopher-caused mortality in the locust area occurred between October 1975 and April 1976. This winter use is consistent with results reported by Burton and Black (1978). Equal winter mortality might have occurred in the grass area had more trees survived the initial establishment period.

DISCUSSION

It is common practice in some parts of the western United States to seed grasses in forested areas which have been devastated by wildfires or other natural or human-caused events. The grass area on the South Fork of Workman Creek is an example of the long-term consequences of this activity. The area now contains a vigorous herbaceous cover of 70% introduced or native grasses. This cover is detrimental to conifer regeneration because of the competition for moisture (Embry 1971), but also because it supports a relatively large valley pocket gopher population–about 24 animals per acre. This population is greater than the 0.22 animals per acre reported for an uncut ponderosa pine stand, on deep soils, near Flagstaff (Goodwin and Hungerford 1979).

Stomach analysis from animals collected during the two field seasons indicates that grasses, especially bromegrass, are an important part of the pocket gopher diet. Although the percentage of grasses decreased over the study from 84% to 44%, their importance was never replaced by forbs. The 84% value is among the highest reported for grass usage by *Thomomys* spp. in a forest

zone. All of the animals had some grass in their stomachs when trapped. At least 16 forbs were available but were generally not used heavily. The shift from bromegrass to thistle in summer 1976 is not surprising, because succulent forbs are considered the preferred food. Laboratory tests have confirmed that pocket gophers can discern preferred foods (Hungerford 1976). Preference indices and tables confirm this relationship.

The relatively large pocket gopher population on the grass area indicates that a diet dominated by grasses, particularly bromegrasses, may be nutriently beneficial. These results differ from feeding habits of *Thomomys talpoides* on mountain grasslands in west-central Colorado (Keith et al. 1959, Tietjen et al. 1967). Differences in grass species composition may influence gopher feeding preferences.

Although forbs are generally preferred by pocket gophers, substantial grass consumption has also been reported in other forest and woodland sites. Burton and Black (1978) found that grasses provided 32% of the annual diet of the Oregon pocket gopher (*T. mazama*) within a disturbed ponderosa pine site. *Bromus* also was the preferred grass on their site. However, grass consumption was lower (17%) during July when more forbs were available. Thirty-eight percent of the summer-fall *T. bottae* diet in a managed Arizona ponderosa pine forest consisted of grasses (Goodwin and Hungerford 1979). Bandoli (1981) reported that grass, primarily blue grama (*Bouteloua gracilis*), accounted for about 30% of the average annual gopher diet and averaged 36% of the summer diet on his pinyon-juniper site, although some perennial forbs were more preferred. Grass and sedge consumption averaged about 25% on the locust area. These values can be compared to the Colorado results which showed low summer-fall grass consumption of 6% (Ward and Keith 1962) and of 18% (Keith et al. 1959).

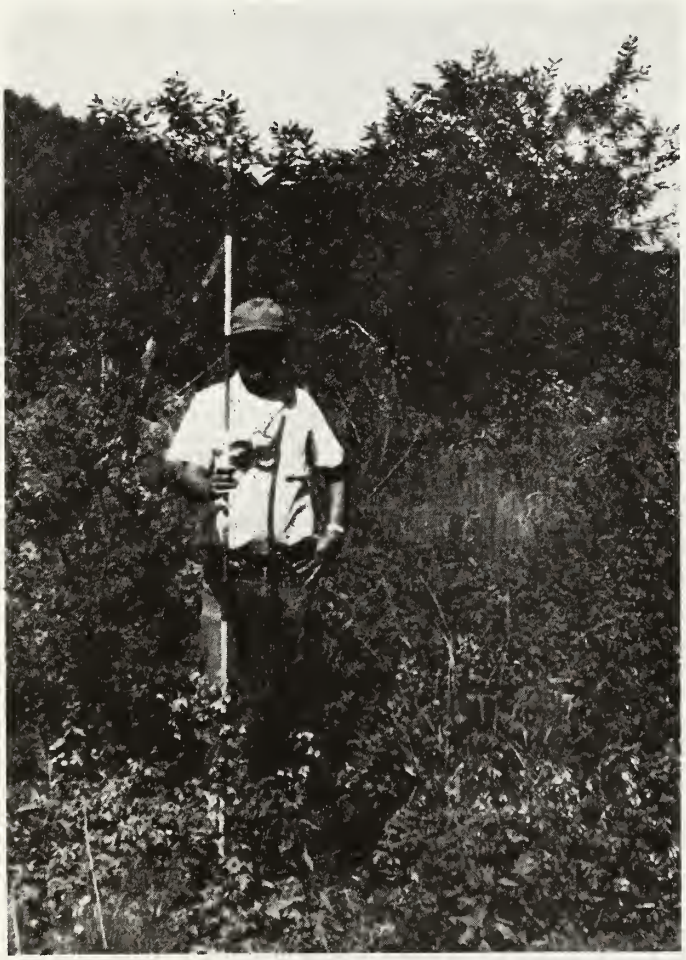

Figure 3.—The diversity of the plant cover on the locust area can be seen at this location, where the cover included ponderosa pine, locust, raspberry, sunflower, and grasses. The photograph was taken in September 1977.

Forb consumption during the two summers averaged 51% in the locust area and was 48% in the grass area during the summer of 1976. These values are consistent with others reported for *T. bottae* or for *T. mazama* on a forest site. Goodwin and Hungerford (1979) reported that 46% of the diet was forbs while Bandoli (1982) indicated consumption of at least 39%. Burton and Black (1978) reported that forbs were 40% of the annual diet and averaged 51% of the July diet. Research in the Colorado mountain grassland showed higher summer-fall forb consumption; Keith et al. (1959) reported 85%, and Ward and Keith (1962) reported 93%.

Pocket gophers killed fewer ponderosa pine trees than expected. Pine survival was statistically better in the locust area but still inadequate to restock the area. Drought and gophers killed seedlings earlier in the grass area than in the locust area. Precipitation was below average during summer 1975. Drought may be more severe under grass than under a locust-forb cover. Gottfried (1980) found significantly more soil moisture in the top 24 inches of soil under 5-year-old locust stands than in grass stands in a site near the grass area. The exact reasons for the mortality in 1975 cannot be determined, but more intensive competition for soil moisture by grasses (Embry 1971) and a slightly higher gopher population are possibilities.

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LITERATURE CITED

Bandoli, James H. 1981. Factors influencing seasonal burrowing activities in the pocket gopher, *Thomomys bottae*. Journal of Mammology 62:293–303.

Burton, Douglas H., and Hugh C. Black. 1978. Feeding habits of mazama pocket gophers in south-central Oregon. Journal of Wildlife Management 42:383–390.

Cottam, Grant, and J. T. Curtis. 1956. The use of distance measures in phytosociological sampling. Ecology 37:451–460.

Crouch, Glenn L. 1982. Pocket gophers and reforestation on western forests. Journal of Forestry 80:662–664.

Embry, Robert S. 1971. Soil water availability in an Arizona mixed conifer clearcutting. USDA Forest Service Research Note RM–206, 4 p. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.

Goodwin, John G., Jr., and C. Roger Hungerford. 1979. Rodent population densities and food habits in Arizona ponderosa pine forests. USDA Forest Service Research Paper RM–214, 12 p. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.

Gottfried, Gerald J. 1980. Control of New Mexican locust and the effect on the planted ponderosa pine in central Arizona. USDA Forest Service Research Note RM–386, 6 p. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.

Heidmann, L. J. 1972. An initial assessment of mammal damage in the forests of the Southwest. USDA Forest Service Research Note RM–219, 7 p. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.

Hungerford, Kenneth E. 1976. Food preferences and food location by pocket gophers in Idaho. p. 131–138. *In* Proceedings seventh vertebrate pest conference. [Monterey, Calif., March 9–11, 1976] 323 p. C. C. Siebe, editor. University of California, Davis.

Keith James O., Richard M. Hansen, and A. Lorin Ward. 1959. Effect of 2,4–D on abundance and foods of pocket gophers. Journal of Wildlife Management 23:137–145.

Marston, Richard B., and Odell Julander. 1961. Plant cover reductions by pocket gophers following experimental removal of aspen from a watershed area in Utah. Journal of Forestry 59:100–102.

Moir, William H., and John A. Ludwig. 1979. A classification of spruce-fir and mixed conifer habitat types of Arizona and New Mexico. USDA Forest Servvice Research Paper RM–207, 47 p. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.

Mood, Alexander M., Franklin A. Graybill, and Duane C. Boes. 1974. Introduction to the theory of statistics. 564 p. McGraw-Hill, Inc., N.Y.

Neu, Clyde W., C. Randall Byers, and James M. Peek. 1974. A technique for analysis of utilization-availability data. Journal of Wildlife Management 38:541–545.

Pase, Charles P., and R. Roy Johnson. 1968. Flora and vegetation of the Sierra Ancha Experimental Forest, Arizona. USDA Forest Service Research Paper RM–41, 19 p. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.

Rich, Lowell R. 1962. Erosion and sediment movement following a wildfire in a ponderosa pine forest of central Arizona. USDA Forest Service Research Note RM–76, 12 p. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.

Rich, Lowell R., and Gerald J. Gottfried. 1976. Water yields resulting from treatments on the Workman Creek Experimental Watersheds in central Arizona. Water Resources Research 12:1053–1060.

Sparks, Donnie R., and John C. Malechek. 1968. Estimating percentage dry weight in diets using a microscopic technique. Journal of Range Management 21:264–265.

Tietjen, Howard P., Curtis H. Halvorson, Paul L. Hegdal, and Ancel M. Johnson. 1967. 2,4–D herbicide, vegetation, and pocket gopher relationships, Black Mesa, Colorado. Ecology 48:634–643.

Ward, A. Lorin. 1960. Mountain pocket gopher food habits in Colorado. Journal of Wildlife Management 24:89–92.

Ward, A. Lorin, and James O. Keith. 1962. Feeding habits of pocket gophers on mountain grasslands, Black Mesa, Colorado. Ecology 43:744–749.

Gottfried, Gerald J., and David R. Patton. 1984. Pocket gopher food habits on two disturbed forest sites in central Arizona. USDA Forest Service Research Paper RM-255, 9 p. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.

Pocket gopher food habits were studied on two nonstocked forest sites. Grasses, especially bromegrass, were between 84% and 44% of the diet on the seeded grass site. Forbs supplied 51% of the diet on a site with forb-grass-brush cover. Ponderosa pine was not used heavily. High use of grasses has management implications.

Keywords: *Thomomys bottae*, valley pocket gopher, food habits, forest regeneration, Arizona

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